REMOTE SENSING TECHNIQUES IN UPDATE GEOLOGIC AND GEOMORPHOLOGIC MAPPING OF SEIF AL UWAYNAT, SOUTHEASTERN LIBYA

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Abstract: Ten colors composite images of Seif Al Uwaynat were obtained by the superimposition of the data of three Landsat Enhanced Thematic Mapper (ETM) bands. After dynamic enhancement processing (Histogram Gaussian Contrast Stretching) facilitate interpretation of the Seif sand dunes and barchans sand dunes information contained in the original Landsat (ETM 7, 4, 2) data. New information is obtained from these ten colors composite images when it is compared with small scale geological data such as the geological map of Seif AL Uwaynat region. The Landsat ETM of this region reveals a textural, moisture content, patterns and color differentiation with the Quaternary deposits which consist of the Seif (longitudinal) sand dunes and clay deposits along their troughs. This differentiation and the results were not observed or mentioned on the geological map of IRC (2007) and Hunting (1974). Another technique has been accomplished to identify terrain features of Seif AL Uwaynat region using band rationing technique. Terrain features of the study area have been identified by this technique from reflectance bands of Landsat ETM image. Twelve band ratios have been created and each ratio has revealed the terrain features. Single color-composite combinations of three ratios have separated subtle differences between different terrain features uniquely. This study has been on the basis of visual interpretation.

Keywords: Landsat Enhanced Thematic Mapper Imagery, Seif Al Uwaynat, Remote Sensing Techniques, Band rationing technique.

INTRODUCTION

The Seif AL Uwaynat area occupies 713 square kilometers and is situated between latitudes 21° 30`N and 21° 45`N and longitudes 24°15`E and 24° 30`E (Figs. 1 and 2). A pronounced feature at the mapped area is the presence of the ends of Seif AL Uwaynat sand dune and extensive sand sheets. The dunes are of longitudinal type oriented as stream lines in northeast–southwest trends. Longitudinal sand dunes in the area of Seif AL Uwaynat area that reaches up to 90km long and usually up to 20m. high. This dune occurs at the western part of the mapped area. There are also dune belts covering a great part of the mapped area and laterally grade into the flat sand sheet forming the plain areas. Most of the undifferentiated Precambrian rocks and the upper member of Carboniferous rocks at the Seif AL Uwaynat area are partially covered by Quaternary deposits (El– Mehdi *et al*, 2004).

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Research Objectives

This study has two major objectives: 1-To test the potential and utility of using remote sensing enhancement techniques. 2-To produce update mapping in geologic and geomorphologic studies derived from analysis of Landsat Enhanced Thematic Mapper imagery by using techniques that requires less time and less expenses than more conventional field mapping.

Justification for Choice of Area

1-Seif Al Uwaynat area is a classical region of geological study which is known in considerable details. However, geomorphologic mapping has lagged behind studies of the geology of the province; in particular, remote sensing data have not been used for geological and geomorphologiacal analysis. 2-The region has sufficient complexity, both of terrain and surface cover, to permit an evaluation of the applicability of Landsat Enhanced Thematic Mapper data to study the geomorphology, structure

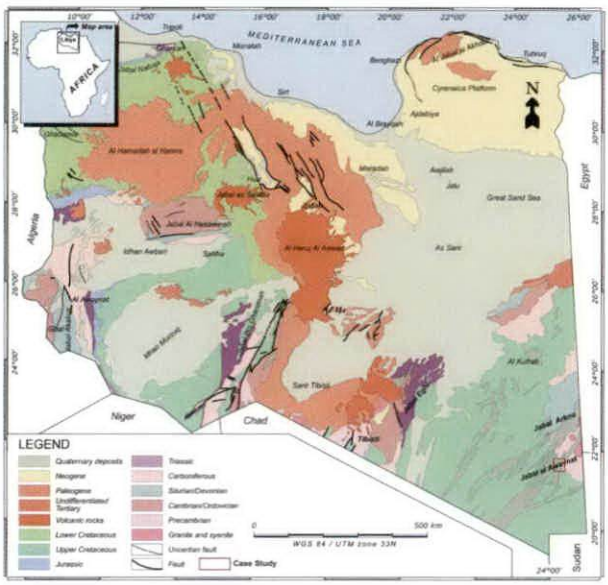


Fig. 1: Location Map of Seif AL Uwaynat Area, geological overview of Libya (modified after Industrial Research Centre, 1977).

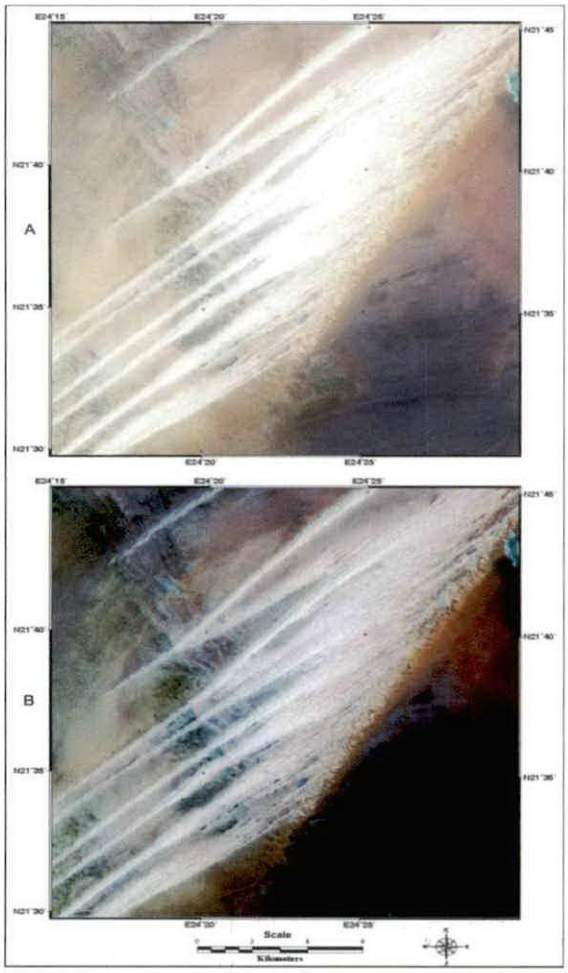


Fig. 2: A – Raw Data of Seif AL Uwaynat Area. B – Landsat Enhanced Thematic Mapper Bands Combination (ETM 7 = Red, ETM 4 = Green and ETM 2 = Blue)

and lithological units in areas of rugged terrain and in flat table area which is difficult to access. 3-The region possesse a broad range of surface condition of two types of sand dunes so that results in this area should have and has economic problems typical of those which occur throughout Al Kufrah Basin, so that results in this area should have a wider applicability. 4-Therefore, it is desirable to sum the knowledge of visual satellite image interpretation to produce a series of updating maps such as, geological, tectonic and geomorphologic maps. These will provide more detailed information on the mappable units and highlight the signature and their appearance on satellite images.

The Evaluation of Enhancement Techniques

The major goal of this study is to develop available methodology for producing remote sensing data flow chart for update mapping geologic and geomorphologic study using remote sensing enhancement techniques. The approach adopted in this study has therefore the following steps as illustrated in the flowchart below (Fig. 3, Lillesand & Kiefer, 1999 and Sabins, 1997).

RESULTS AND INTERPRETATION

The principal findings of this research are: 1-Landsat ETM 7, 4, 2 band imagery synoptic view of the Seif AL Uwaynat provided the basis for update geologic interpretation (Fig. 4). Published map (IRC, 2007) on the lithological mappable units was updated therefore, some discrepancies were found, as follows: This study has corrected the misinterpreted the boundary of the mappable units by IRC, 2007 (Figs. 4 and 5). 2-To the author's knowledge, no geomorphologic interpretation previously was available (Fig. 6), and therefore, the present work should greatly highlight the landforms analysis of the district. 3-It was noticed from Landsat ETM 7, 4, 2 that the Seif sand dunes longitudinal pattern were developed and appeared in a very sharp boundary with white appearance due to the high spectral reflectance of white quartz grains in blue, green and red (i.e., Blue+Green+Red=White). Whereas, the isolated trough between the two crests was developed in clay deposits and appear in blue color because the clay deposits has high spectral reflection in green band (ETM2). In the color composites of ETM 7, 4, 2, has been assigned to a particular color gun of

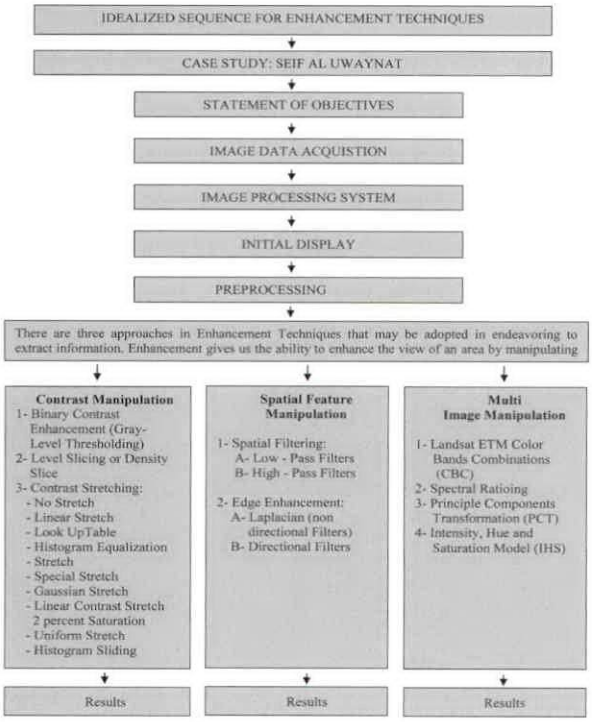


Fig. 3: Flowchart illustrating the methodology adopted in the present study, Lilles and, T.M., and R.W. Kiefer, 1999, and Sabins, F.E., 1997).

RGB composite, that is why the clay trough appears in blue color (Fig. 7).

4-The optimum Landsat ETM channels for lithological and structural discrimination was ETM1, ETM5 and ETM7 (Fig. 8). Histogram Gaussian Contrast Stretch was used to improve image contrast, and was effective in highlighting and enhancement of terrain features in table land terrain as in Seif AL Uwaynat. 5-Color composites of different bands (Figs. 7 and 9) have been selected. Each of the three (ETM) color composites has been assigned to a particular color gun of RGB composites. These twelve color composites of different band allow for the discrimination of terrain features and material classes in a scene. 6-Terrain features can be fairly detected and mapped using color combination of three ratioed images. In this study, twelve band ratios were created. Each ratioed image enhanced at least two or more terrain features (Fig. 10). Three colors composite combinations of three band ratios were classified all terrain features (Fig. 11 and Table 1). 7-Another technique was carried out here with Landsat ETM prepared in the

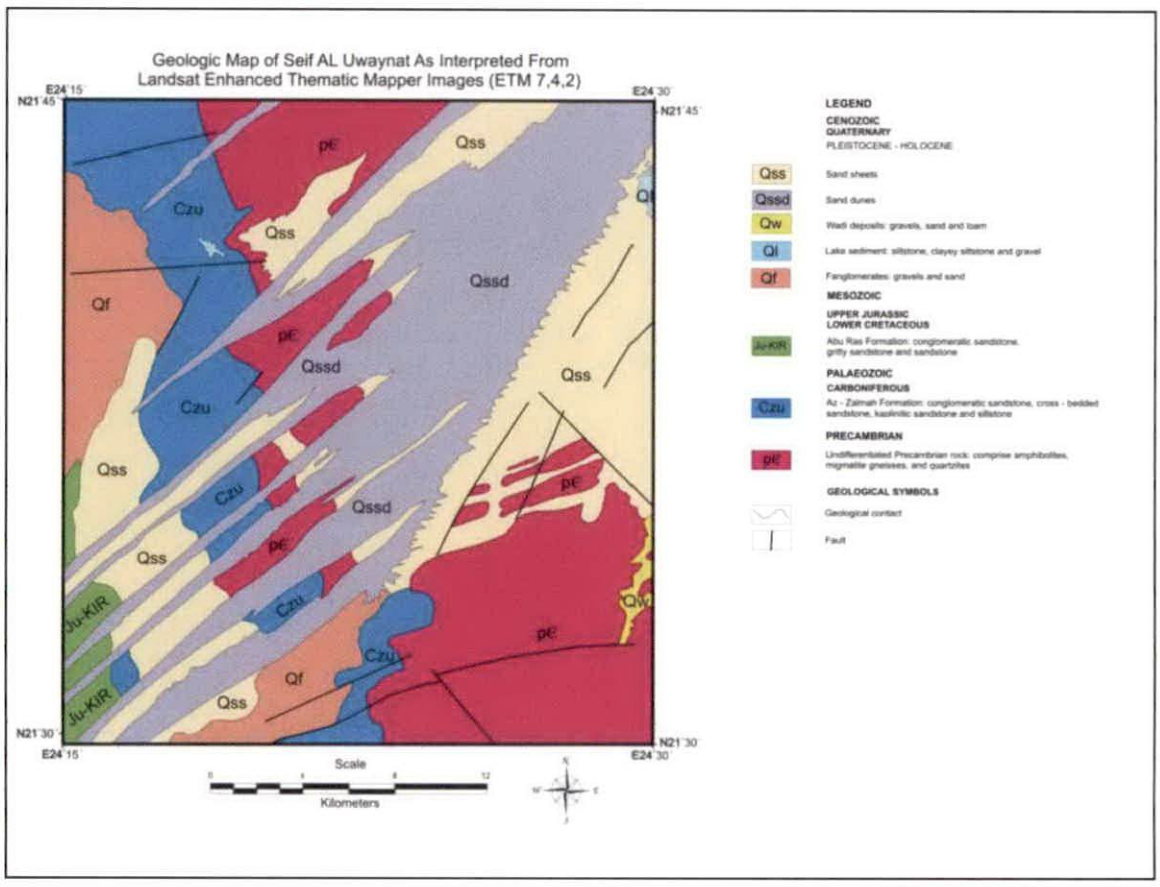


Fig. 4: Geologic Map of Seif AL Uwaynat.

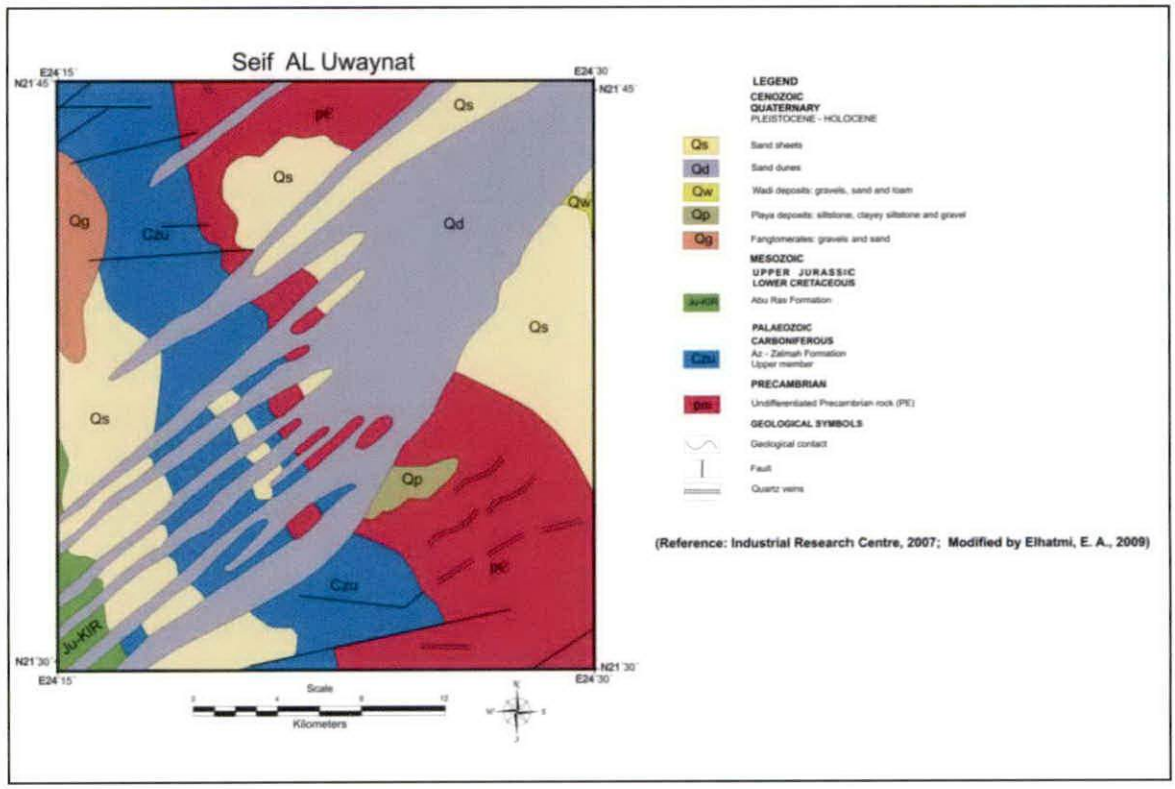


Fig. 5: Geologic Map of Seif AL Uwaynat (IRC, 2007).

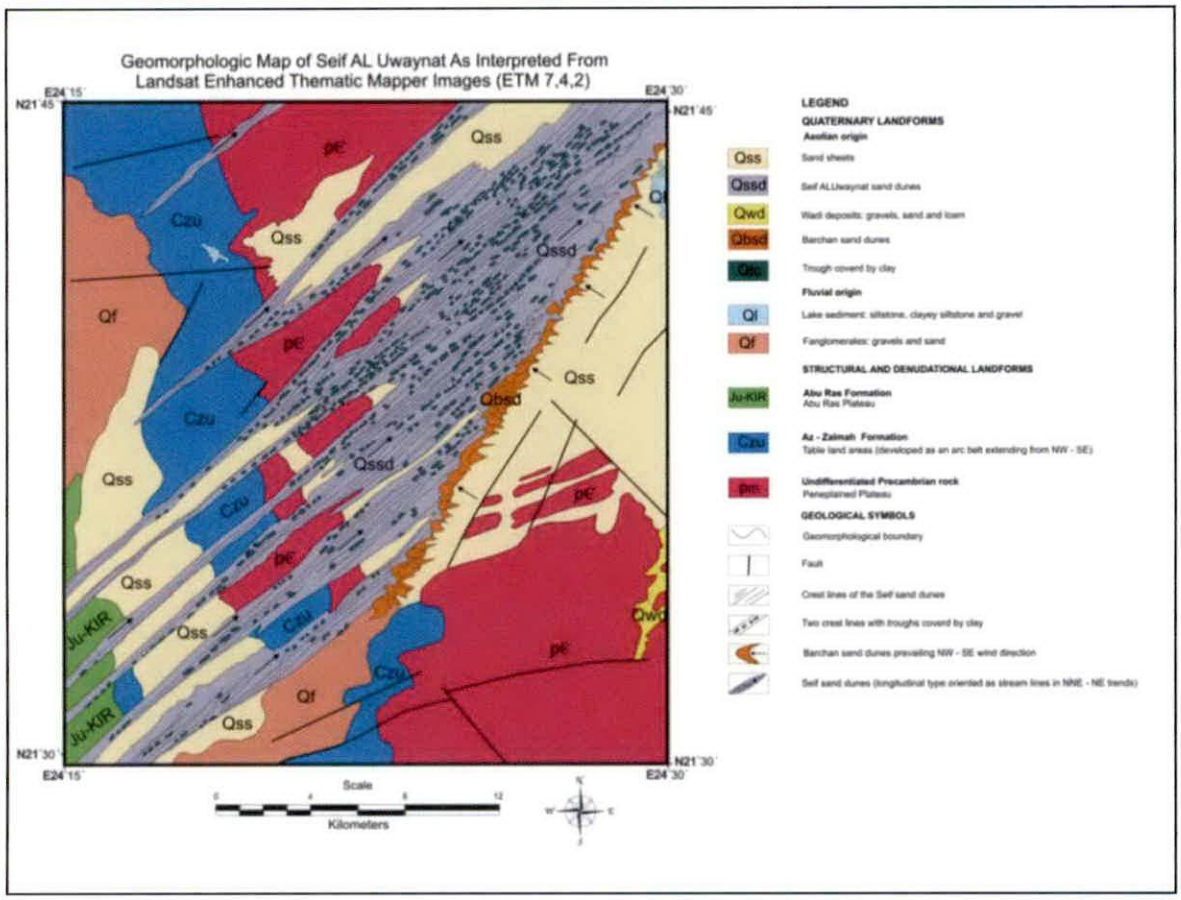


Fig. 6: Geomorphologic Map of Seif AL Uwaynat.

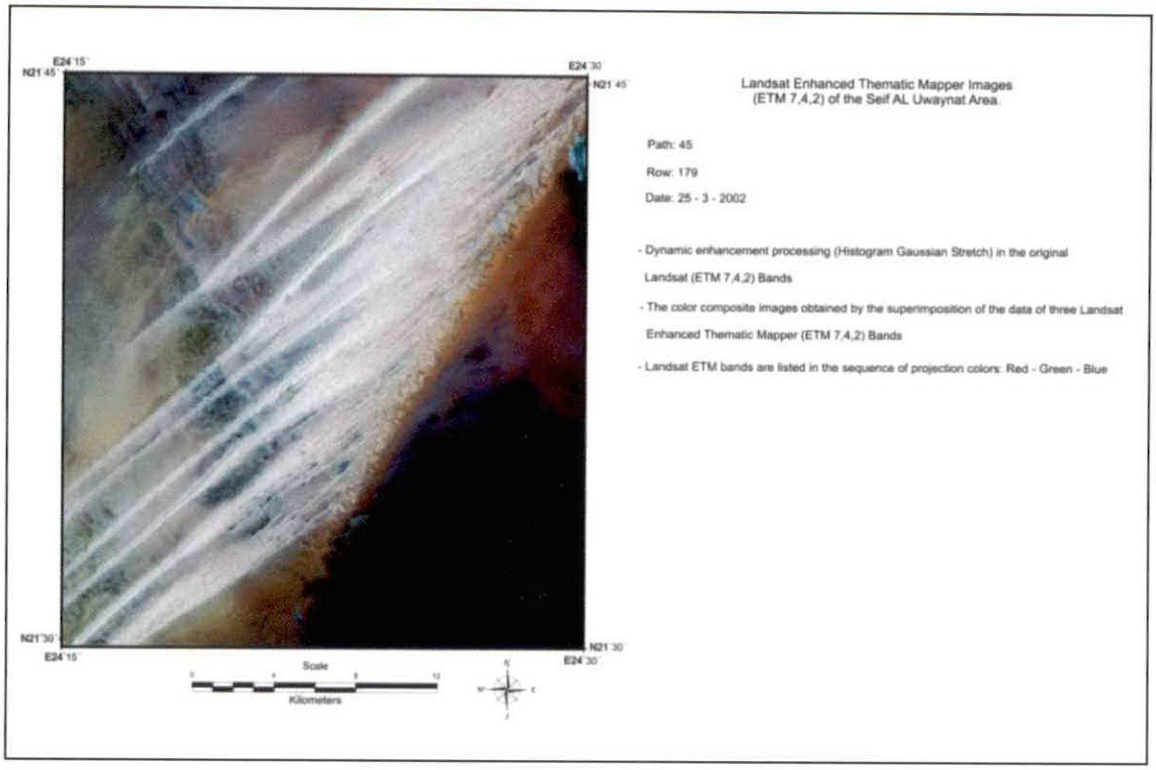


Fig. 7: Landsat Enhanced Thematic Mapper Images (ETM 7,4,2) of the Seif AL Uwaynat.

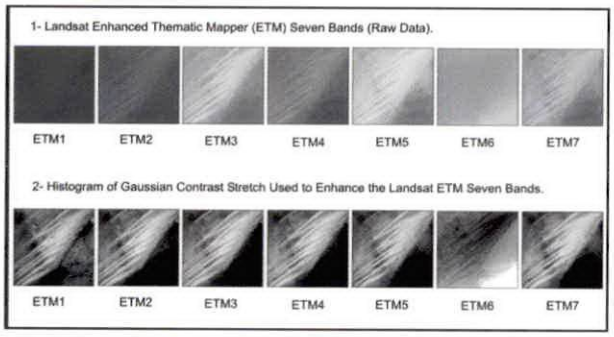


Fig. 8: Original Landsat (ETM) images and the dynamic enhancement contrast Stretch Gaussian applied in Seif AL Uwaynat.

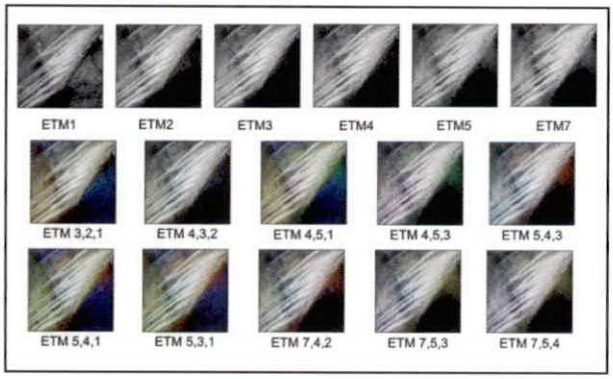


Fig. 9: Landsat (ETM) images resulting from applied of histogram Gaussian contrast stretch and color – composite cominations applied in Seif ALUwaynat.

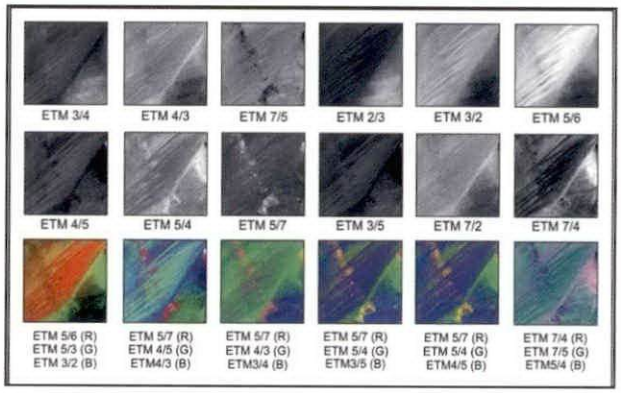


Figure 10: Twelve ratio combinations for Landsat (ETM) applied in Seif AL Uwaynat and six color – composite combinations of band ratios, applied in Seif AL Uwaynat

form of High–Pass and Low-Pass, and the results were suitable the technique was and efficient for Seif AL Uwaynat.(Figs. 12 and 13). 8-Principle Component Transformation and Intensity–Hue–Saturation Color Space Transformation has been identified terrain features, but they are not the best and suitable techniques for discrimination terrain features of the Seif AL Uwaynat.(Fig. 14).

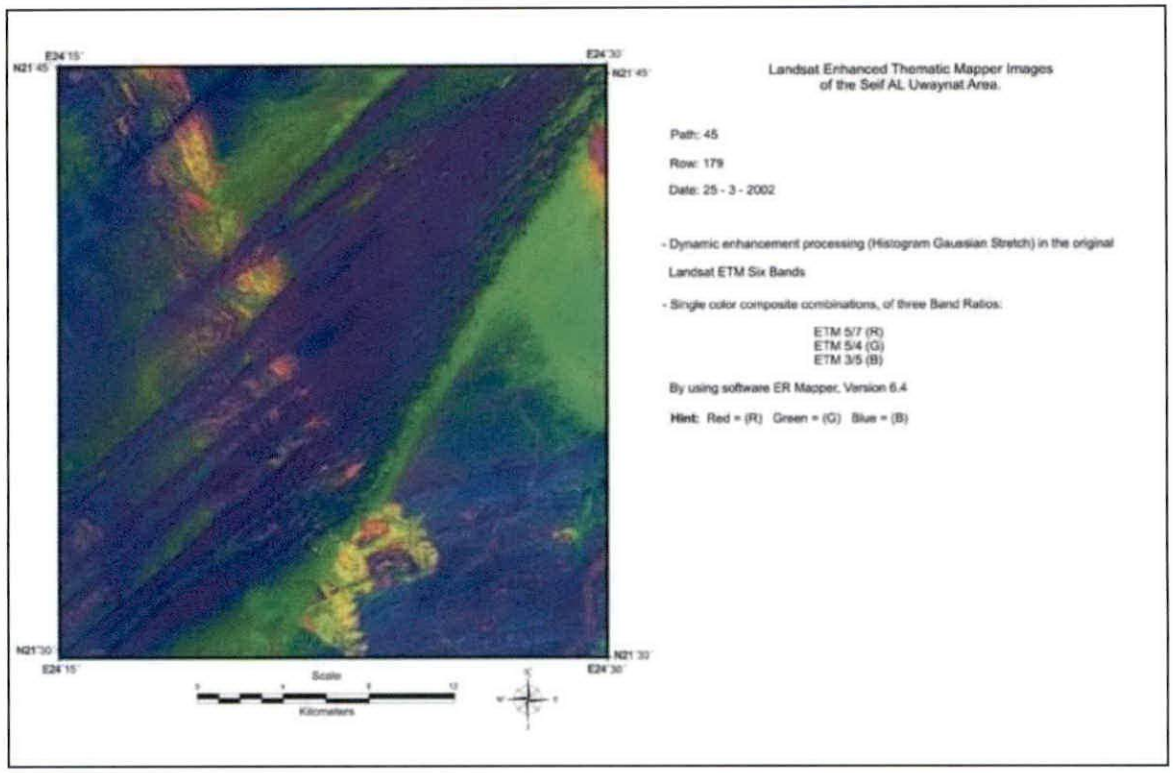


Figure 11: Single color composite combinations, of three Band Ratios ETM 5/7, ETM 5/4 and ETM 3/5.

CONCLUSIONS

The color composites images were obtained the superimposition of the data of three Landsat Enhanced Thematic Mapper (ETM) 7, 4, 2 bands. After dynamic enhancement processing (Histogram Gaussian Contrast Stretching) facilitate interpretation of the Seif sand dunes and Barchan sand dunes information contained in the original Landsat ETM (7,4,2) data. New information is obtained from these images even though it is compared with the small scale geological map of Seif AL Uwaynat area (Figs. 4 and 6). In this regard the map of IRC (2007) and Hunting (1974). The Landsat ETM of this region reveals of textural, pattern and color differentiation with the Quaternary deposits which consist of the Seif (longitudinal) sand dunes and clay deposits along their troughs. As this differentiation was not observed or mentioned on the geological map of IRC (2007) and Hunting (1974).

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Table 1: Three band ratios applied in Seif AL Uwaynat Figure 1: Location Map of Seif AL Uwaynat Area, geological overview of Libya

ETM 5/7	(R)
ETM 5/4	(G)
ETM 3/5	(B)
ETM 7/4	(R)
ETM 7/5	(G)
ETM 5/4	(B)
ETM 5/6	(R)
ETM 5/3	(G)
ETM 3/2	(B)

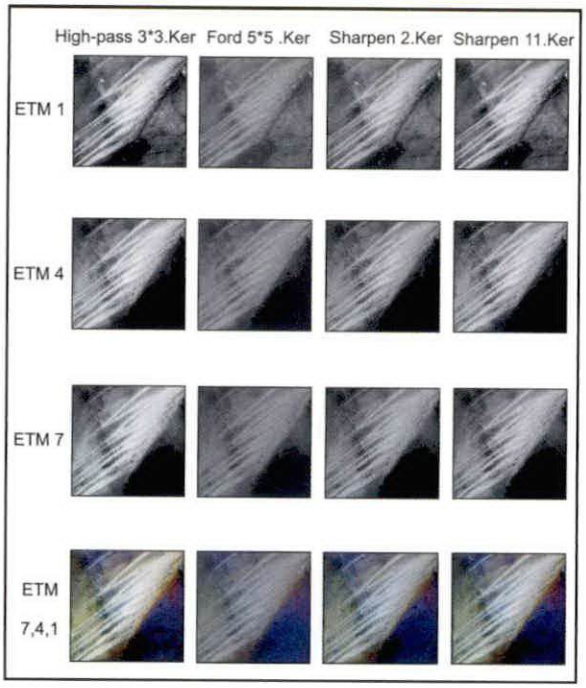


Figure 12: Landsat (ETM 7,4,1) images resulting from application of algorithm spatial filtering High – Pass applied in Seif AL Uwaynat.

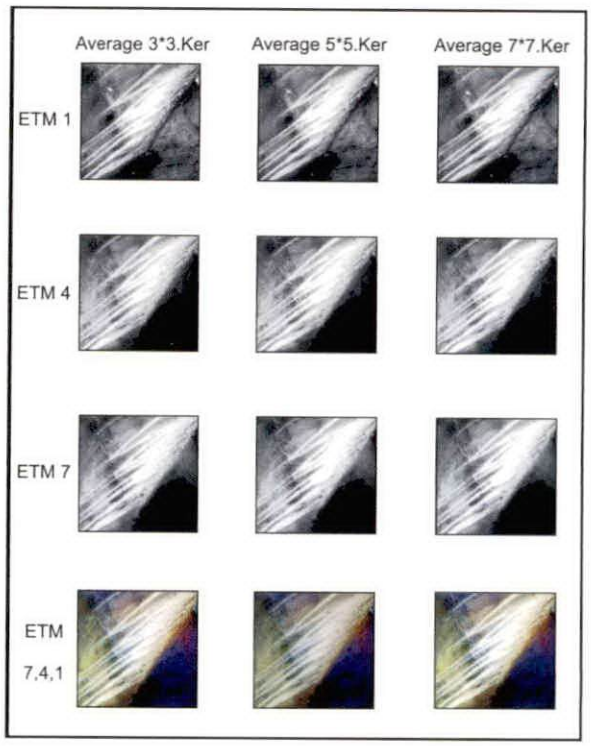


Figure 13: Landsat (ETM 7,4,1) images resulting from application of algorithm spatial filtering Low – Pass applied in Seif AL Uwaynat.

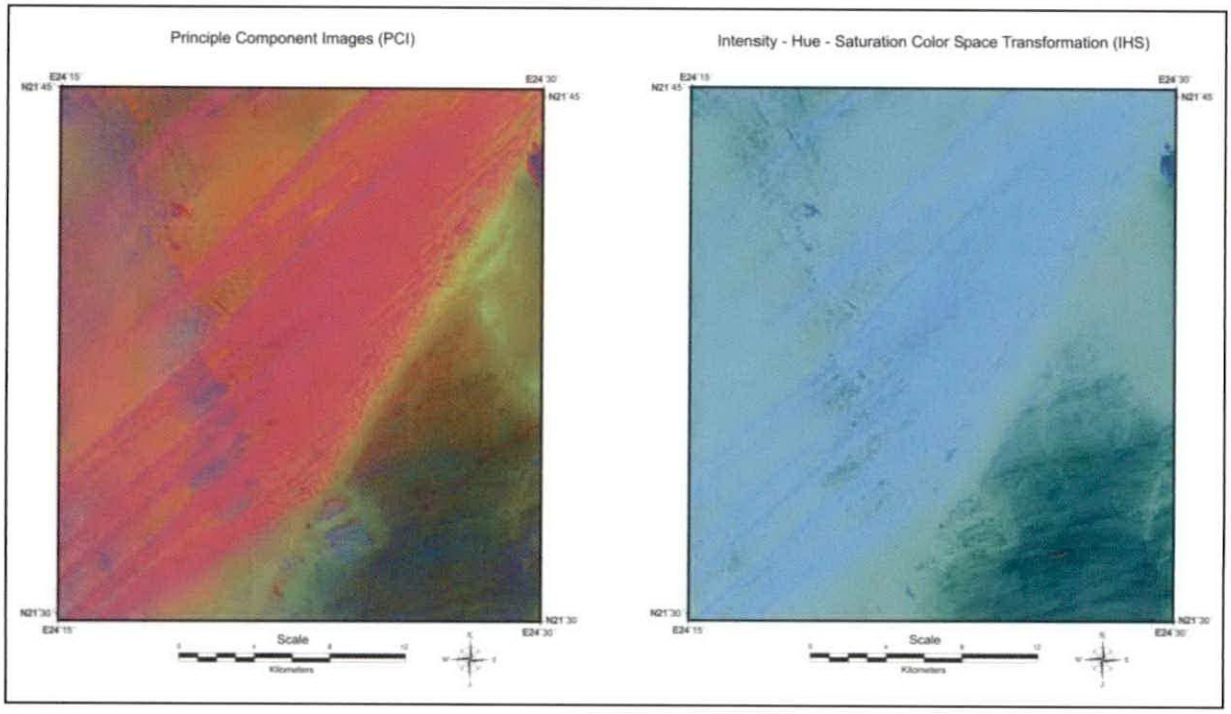


Figure 14: PCI and IHS applied in Seif AL Uwaynat

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